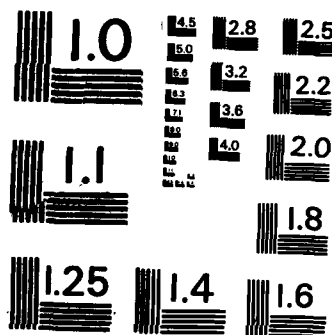


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SELF-CONTAINED NAVIGATION S. (U) LEAR SIEGLER INC GRAND
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OPERATING AND SUPPORT HAZARD ANALYSIS

FOR THE

SELF-CONTAINED NAVIGATION SYSTEM

LSI MODEL 6216A, B, & C

GROUP "A"

Report No. 6216-014

Contract No. F09603-85-C-1224

Data Item 0103

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Date:

86-3-13

Date:

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1.0 GENERAL - This document constitutes the Operating and Support Hazard Analysis (O&SHA) for the C-130 Self-Contained Navigation System (SCNS) installation. It provides a hazard assessment of use and maintenance of the SCNS installation.

1.1 PURPOSE - IAW MIL-STD-882A, the purpose of an O&SHA is to identify and control hazards to personnel and to the system, or related to production, installation, maintenance, test, operation, etc. This O&SHA is limited to installation and checkout of the A-kits and system and to the safety of personnel working in or around the equipment, including ground and flight crews.

1.2 SCOPE - The scope of this analysis for Data Item 0103 is limited to the SCNS installation task² "A-kit" components (viz. wiring harness, brackets, racks, control panels, relay boxes, circuit breakers), "B-kit" components (viz. ICDUs, BICU, DVS, INU), and the physical interfaces with existing equipment (viz. CADC or Sensors, Radar, Air Data Sensors). These items will be analyzed in respect to safe installation, safe hardware, and safe usage (viz. installation, removal, in-place test, and handling).

2.0 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS - The following documents of the exact issue shown are used in the preparation of this analysis and report.

MIL-STD-882A	System Safety Program Requirements (paragraph 5.5.1.4).
DI-H-7048	System Safety Hazard Analysis Report (paragraph 10.2.4)
DH1-6 (Edition 5)	System Safety Design Handbook
SOW 84-MMSRE-004-C-130-SCNS Rev. J	C-130 Modification Self-Contained Navigation System (SCNS), Statement of Work for
84-MMSRE-009-C-130 Rev. J	Self-Contained Navigation System (SCNS), Integration, Fabrication and Installation and Test of, C-130 Aircraft

2.2 NON-GOVERNMENT DOCUMENTS - See table II and III.

3.0 SYSTEM DESCRIPTION

- 3.1 GENERAL DESCRIPTION - The SCNS is comprised of a Doppler Velocity Sensor (DVS), Inertial Navigation System (INS), Integration Computation and Display System (ICDS), and the associated installation Group A kit to provide doppler aided INS navigation, INS only, Doppler only and TAS/HDG navigation modes, and control of the various C-130 communication/navigation (comm/nav) systems. The SCNS ICDS consists of three Integrated Control Display Units (ICDU) and one Bus Integration Computer Unit (BICU) for all C-130 aircraft except that the HC-130H will have an additional ICDU for the radio control. A block diagram is shown in figure 1.

In conjunction with the SCNS installation, the following systems/components will be removed from the various C-130 configurations.

AN/APN-147 Doppler
AN/ASN-35 Doppler Computer
ARN-131 Omega
AN/ASN-24 or PINS (C-130E AWADS only)

Radio controls for

AN/ARC-164 UHF (one control retained)
AN/ARC-186 VHF
AN/ARC-190 HF
AN/ARN-118 TACAN
AN/ARN-127 VOR/ILS
USAF Standard VOR/ILS

The communication and navigation radio control functions will be assumed by the ICDUs except during an emergency use of a UHF backup manual control head.

- 3.2 MAJOR COMPONENTS - A list of major components is provided in table I.

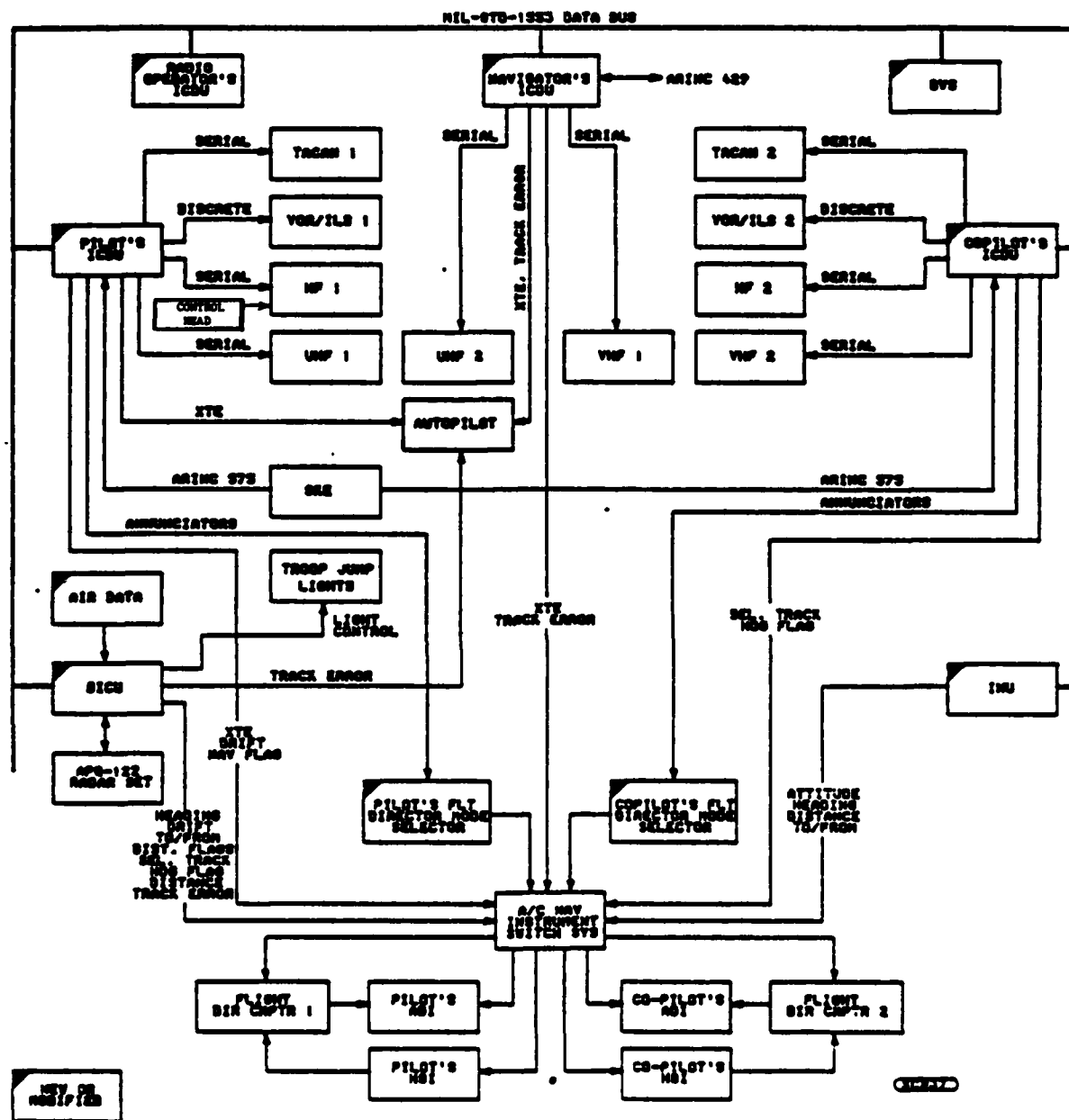


Figure 1. SCNS Block Diagram

Table I. Major Component List

MODEL NO.	GROUP		DESCRIPTION	LOCATION
	A	B		
LSI-2580F		✓	Integrated Control Display Unit	Left side forward on center console for pilot. Right side forward for co-pilot. Nav panel for navigator. Radio operator's panel for HC-130.
LSI-2905A		✓	Bus Interface Computer Unit	New equipment rack.
LSI-2905B		✓	Bus Interface Computer Unit with Added Radar Interface Card (AWADS)	New equipment rack.
LSI-2590A APN-218		✓	Doppler Velocity Sensor	Belly of aircraft
SNU 84-1		GFE	Inertial Navigation Sensor	Aircraft floor below new equipment rack
-	✓		Electrical A-Kit	Several variations
-	✓		Mechanical A-Kit	Several variations
-	✓		Flight Director Mode Select panel modifications	Instrument Panel (also a panel on the pedestal for C-130B)
-	✓		SCNS Control Panel	Nav Station
-	✓		INU Battery	Battery Compartment

- 3.2.1 ICDS - The ICDS consists of two major components: the Integrated Control Display Unit (ICDU) and the Bus Integration Computer Unit (BICU). All aircraft configurations utilize fully interchangeable ICDUs: pilot's, co-pilot's, navigator's and radio operator's (HC-130H). Jumper wires in the aircraft installation indicate its particular station location to each ICDU. One basic BICU design is utilized in all SCNS configurations with the exception of the BICU for the AWADS aircraft. It adds a third circular connector and SRUs for the radar interface. Connector jumper wires indicate to the BICU into which aircraft model it is installed.
- 3.2.2 INS - The Inertial Navigation System (INS) consists of three major components: the Inertial Navigation Unit (INU), the INU mount, and the SCNS battery subsystem. The SCNS INU conforms to requirements of the F³ SNU 84-1 and SNU 84-3 specifications.
- 3.2.3 DVS - The Doppler Velocity Sensor (DVS) consists of the APN-218 Air Force Standard Doppler. The DVS provides basic navigation inputs for SCNS independent doppler navigation capability and for integrated INS/Doppler capability.
- 3.3 SYSTEM FUNCTIONS - The SCNS primary function is to provide highly accurate and reliable self-contained navigation capability for the MAC C-130 Tactical Airlift Operations. These missions and operations are defined in MACR 55-130, Military Airlift Command Regulation.
- 3.3.1 MAJOR FUNCTIONS - The SCNS provides the following major functions.
- ☐ Navigation modes and position update capability.
 - ☐ Integrated control and display of navigation, communication, guidance, and steering functions.
 - ☐ Aircraft guidance and steering - including flight plan, time of arrival, CARP, SAR, and rendezvous.
- 3.3.2 SECONDARY FUNCTIONS - Additional features are provided to improve performance, reduce crew workload, and minimize aircraft maintenance time. Specifically, these are:
- ☐ TACAN mixing to improve navigation accuracy.

- ☐ CARP capability that will reduce crew workload and increase mission flexibility.
- ☐ Simple, accurate, and quick magnetic compass calibration procedures.

3.4

A-KITS - The "A" kits consist of:

- ☐ The interconnecting cables between added LRUs.
- ☐ The interconnecting cables and modifications to cables connecting existing LRUs.
- ☐ Mounting trays and hardware.
- ☐ Sheet metal work as required.
- ☐ Control panels
- ☐ Blank panels
- ☐ Annunciator lights
- ☐ Pressure sensors
- ☐ Circuit breaker changes and additions.



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- 4.0 SAFETY CRITERIA - Certain safety criteria IAW MIL-STD-882A are followed in this O&SHA.
- 4.1 SYSTEM SAFETY PRECEDENCE - Any items detected as fitting into hazardous categories are treated in the following order:
- a. Redesign to eliminate the hazard, if possible.
 - b. Change operating procedure to eliminate or reduce occurrence.
 - c. Provide training recommendations to allow personnel to safely work in the presence of the hazard.
 - d. Label or placard hazards and provide inputs to manuals.
- 4.2 HAZARD LEVEL CATEGORIES - (criticality definitions) For the purpose of the hazard analysis, the hazards will be defined and categorized IAW the criticality definitions set forth below (ref. MIL-STD-882A, para. 5.4.3.1).
- 4.2.1 HAZARD SEVERITY - Hazard severity categories are defined to provide a qualitative measure of the worst potential consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, system, subsystem or component failure or malfunction as follows:
- a. Category I - Catastrophic - May cause death or system loss.
 - b. Category II - Critical - May cause severe injury, severe occupational illness, or major system damage.
 - c. Category III - Marginal - May cause minor injury, minor occupational illness, or minor system damage.
 - d. Category IV - Negligible - Will not result in injury, occupational illness, or system damage.

4.2.2

HAZARD PROBABILITY - The probability of the defined hazard occurring is based on a qualitative judgement for the purpose of this hazard analysis. The probability levels quoted here are from MIL-STD-882A, Para. 5.4.3.2.

DESCRIPTIVE WORD	LEVEL	SPECIFIC INDIVIDUAL ITEM	FLEET OR INVENTORY
Frequent	A	Likely to occur frequently	Continuously experienced
Reasonably Probable	B	Will occur several times in life of an item	Will occur frequently
Occasional	C	Likely to occur sometime in life of an item	Will occur several times
Remote	D	So unlikely, it can be assumed that this hazard will not be experienced	Unlikely to occur but possible
Extremely Improbable	E	Probability of occurrence cannot be distinguished from zero.	So unlikely, it can be assumed that this hazard will not be experienced.
Impossible	F	Physically impossible to occur	Physically impossible to occur

- 5.0 HAZARD ANALYSIS - The sources of data for the O&SHA are the drawings for the installation kits, the wiring interconnects interface control drawing, the panel and console modifications, the "B" component outline drawings, system block diagrams, grounding and shielding diagrams, process specifications and test procedures.

Data references are given in table II and III. Any items found during the review of those data are listed on the O&SHA matrix sheets. The safety concerns generally apply to all C-130 models and configurations. Where applicable to only specific models, the items will be so annotated. The source information available at this writing is very preliminary, therefore items listed in the matrix sheets are tentative and subject to change in later submittals.

- 5.1 O&SHA MATRIX SHEETS - These sheets are used to list potential hazards related to physical installation, maintenance, repair and use of the installed system. The report does not cover mission functional operation. Recommendations for remedial action are also indicated on the matrix sheets.

- 5.2 SUMMARY - At this early stage of design, no serious safety concerns have been detected that are not already being considered and corrected in the on-going design effort. The status of these concerns listed in the matrix sheets will be monitored for satisfactory resolution, and the entire installation will be thoroughly reviewed when the design and drawings are firm. An update of this O&SHA will be provided at that time.

Table II. Drawings Reviewed

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	COMMENTS
1	408000	Preliminary	System Interconnect Drawing (All C-130)	Reviewed
2	408010	Preliminary	AWADS changes	
3	408020	In work	E, H, and WC E & H models	Not available
4	408030	In work	HC models of H, N & P	Not available
5	408040	In work	Late H models	Not available
6	408050	In work	C-130B	Not available
7	408100	Preliminary	Installation C-130 SCNS	Not available
8	408XXX	In work	440 sub installation drawings	Not available
9	SC862/A	System sketch	None	Reviewed
10	408308	Preliminary	Copilots ICDU mount	Needs rubber pad
11	168647-01-01	Preliminary	SCNS Control Unit	OK
12	L0168648	Preliminary	Control Unit SCNS Display	OK
13	168700	Preliminary	SCNS Control Unit Light Panel	OK
14	L0168720	Preliminary	Control Unit Mode Select C-130B	Reviewed
15	408312	Preliminary	Copilot Side Panel Assembly	Reviewed

Table II. Drawings Reviewed (Continued)

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	COMMENTS
16	L0408300	Preliminary	Equipment rack	Reviewed
17	L0408605	Preliminary	DVS adapter ring	Reviewed
18	168396-01-01	Preliminary	ICDU	Reviewed
19	LG2905A	Preliminary	BICU layout	Reviewed
20	168124	Preliminary	Chassis, Electric Equipment (BICU)	Reviewed



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Table III. Specifications and Documents Reviewed

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	COMMENTS
1	CA1047-002	Preliminary	System Specification for the C-130 Self Contained Navigation System (SCNS) for the C-130B, C-130E (non AWADS), C-130H, HC-130P, WC-130E, and WC-130H Aircraft	
2	CA1047-001	Preliminary	Interface Specification for the C-130 Self Contained Navigation System (SCNS) for the C-130B, C-130E (non AWADS), C-130E (AWADS), C-130H, HC-130H, HC-130N, HC-130P, WC-130E, and WC-130H Aircraft	
3	CA1047-003	Preliminary	System Specification for the C-130 Self Contained Navigation System (SCNS) for the HC-130H Aircraft	
4	CA1047-004	Preliminary	System Specification for the C-130 Self Contained Navigation System (SCNS) for the C-130E (AWADS) Aircraft	
5	CB1047-001	Preliminary	Critical Item Development Specification for the Integrated Control/Display Unit (ICDU) of the C-130 Self Contained Navigation System (SCNS) for the C-130B, C-130E (non AWADS), C-130E (AWADS), C-130H, HC-130H, HC-130N, HC-130), WC-130E, and WC-130H Aircraft	Safety grounding paragraph added

Table III. Specifications and Documents Reviewed (Continued)

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	COMMENTS
6	CB1047-002	Preliminary	Critical Item Development Specification for the Bus Integration Computer Unit (BICU) of the C-130 Self Contained Navigation System (SCNS) for the C-130B, C-130E (non AWADS), C-130H, HC-130H, HC-130N, HC-130P, WC-130E, and WC-130H Aircraft	Safety grounding paragraph added
7	CB1047-003	Preliminary	Computer Program Development Specification for the Integrated Control/Display Unit (ICDU) of the C-130 Self Contained Navigation System (SCNS) for the C-130B, C-130E (non AWADS), C-130E (AWADS), C-130H, HC-130H, HC-130N, HC-130P, WC-130E, and WC-130H Aircraft	
8	CB1047-005	Preliminary	Addendum to Critical Item Development Specification. Specification No. CB1047-002, for the Bus Integration Computer Unit (BICU) of the C-130 Self Contained Navigation System (SCNS) for the C-130E (AWADS) Aircraft	
9	YV1237	Preliminary	The Program/Hardware Interface Specification (PHIS) for the Integrated Control/Display Unit (ICDU) Model 2580F	
10	YV1238	Preliminary	The Program/Hardware Interface Specification (PHIS) for the Bus Integration Computer Unit (BICU) Model 2905A and 2905B	

SUBSYSTEM SCNS		OPERATING HAZARD ANALYSIS				PREPARED BY: PAGE 1 OF 4	
SUBSET Group A		HAZARD ANALYSIS				ISSUE DATE REV.	
ITEM NO	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEVEL	CONTROLS & COMMENTS	
1.	Moving in/out of copilot seat.	Gouge or bump knee or shin on corner of C.P. ICDU.	Corner out where easily bumped. No other way to install ICDU.	III	A	Design mount with corner protected by bonded-on high density foam corner approximately 0.25" thick will reduce class to IV and level to E.	
2.	Removal and installation of pilots ICDU	Damage to connecting cables. Damage to ICDU.	When removing ICDU only a minimum cable length is available. Pulling up on the ICDU too rapidly could result in wire strain and/or dropping the ICDU when the cable becomes taut.	III	C	Provide adequate precautionary notices in maintenance T.O.'s. Possibly add "Remove and install with care" decal on sides of ICDU up close to faceplate will reduce level to D.	
3.	Loading of cargo or cargo shifting.	Damage to INU or effect on alignment.	Aft end of INU only inches from removable light weight panel separating cargo compartment and equipment rack and INU floor mount.	II	C	Add structural buffer to protect INU. This would lower class to IV and Level to E.	
4.	Small arms fire injury during search or rescue mission.	Reduced protection for copilot from light arms ground fire.	Removal of some armor plate for installation of C.P.'s ICDU and side panels. Most of this armor removal is done with secure voice installation. A small additional amount is removed for SCNS.	III	C	This condition exists only on KC-130H, N and P models (21, 15 and 15 respectively). No obvious solution other than hard plate added outside.	

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

PROBABILITY: A - FREQUENT
B - REASONABLY PROBABLE
C - OCCASIONAL

D - REMOTE
E - EXTREMELY IMPROBABLE
F - IMPOSSIBLE

SUBSYSTEM SCNS		OPERATING HAZARD ANALYSIS				PREPARED BY: PAGE 2 OF 4		ISSUE DATE REV.	
SUBSET Group A									
ITEM NO	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEVEL	CONTROLS & COMMENTS			
5.	Changing Mag heading to True heading on the NSI.	Pilot forgets which he is using resulting in Nav error and/or must call up proper page on ICDU to determine the assigned choice.	No positive indicator near the NSI to advise Pilot or C.P. of True, Mag, or Grid headings.	III	B	Some aircraft have indicator lights near the NSI to indicate displayed heading mode (Navy P-3). Some do not indicate displayed mode (C-141 and C-5). It is believed that a C-130 will typically be operated under much higher crew stress conditions than are C-141 or C-5 aircraft. Therefore, the chances of error are greater for C-130 crews. Addition of warning lights would relieve this concern and reduce class to IV and Level to E.			
6.	Use in rainy and/or cold weather.	Water is pulled through by cooling fan affecting operation. Water fills groove (channel) around keys and freezes causing keys to be inoperative.	Rain water leaking in C.P. window when on ground or unpressurized.	III	C	Water cannot enter case or key contacts through the face plate but could conceivably enter through ventilation holes in case. It has been suggested that a thin transparent flexible sheet cover be supplied to totally cover the C.P. Keyboard and CRT display. This would deflect any water and would cause minimal interference with key visibility and actuation.			
7.	Periods of high communications work loads.	Fumbling through 3 separate volume controls to set desired audio level. Finding which one of 3 is turned off.	Same as existing condition. 1. Audio level on radio control head. 2. Audio level set on intercom individual source level control. 3. Setting of intercom master level control.	III	A	Eliminate 3rd excess control with elimination of control heads. Do not add control to ICDUs or extra (damage vulnerable) single control panel or remote in BICU. Adjust for preset consistent maximum levels using resistor "L" or "T" pads in the "A" kit wiring. This would reduce class to IV and Level to D.			

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

PROBABILITY: A - FREQUENT
B - REASONABLY PROBABLE
C - OCCASIONAL

D - REMOTE
E - EXTREMELY IMPROBABLE
F - IMPOSSIBLE

SUBSYSTEM SCNS		OPERATING HAZARD ANALYSIS				PREPARED BY: PAGE 3 OF 4		ISSUE DATE REV.			
SUBSET Group A		EFFECT/HAZARD		CAUSE		CLASS		LEVEL		CONTROLS & COMMENTS	
ITEM NO	CONDITION/EVENT	EFFECT/HAZARD		CAUSE		CLASS		LEVEL		CONTROLS & COMMENTS	
8.	In flight INS alignment.	Transient to auto-pilot, possible loss of SCNS computer load.		Reset recycle power to OFF and back to allow INS to get to STBY prior to in-flight align. If OFF too long, will lose everything in non-protected memory.		III		C		Provide separate power switching for INS (as is done for DVS). This will allow in-air align without perturbing SCNS or other systems using SCNS references. Change will move CLASS to IV and LEV to F.	
9.	Flight.	Loss of SCNS redundancy switching and DVS.		SCNS relays and DVS powered from same breaker.		III		C		This is a single point failure for DVS and SCNS redundancy switching.	
10.	Combat.	Loss of SCNS control relays due to damage from enemy fire.		All SCNS relays, power on and redundancy switching, are in one relay box.		III		D		The odds of bullet damage through the relay box is small compared to other failure causes. The odds could be improved by separating redundant relays into two locations. "Fail Safe" positions need to be evaluated before the next edition of OMA.	
11.	Flight.	NSI and/or ADI, FDI, or AHI confusion in indications.		Different indicators on same instrument driven by unknown sources.		III		C		The redundant sources of information driven by relay selection and software selection may result in pointers driven by several different solutions. This has not been evaluated at this time and may or may not be a safety problem. It is a concern until evaluated. Results will be contained in the next edition of the OMA.	

D - REMOTE
E - EXTREMELY IMPROBABLE
F - IMPOSSIBLE

PROBABILITY: A - FREQUENT
B - REASONABLY PROBABLE
C - OCCASIONAL

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

SUBSYSTEM		SCNS		OPERATING HAZARD ANALYSIS				PREPARED BY: PAGE 4 OF 4		ISSUE DATE REV.	
SUBSET		Group A									
ITEM NO	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEVEL	CONTROLS & COMMENTS					
12.	Ground Test/Operation.	Operator or maintenance fatigue.	Excessive cooling fan noise.	III	A	Attempt to substitute quieter fans in design. Possibly use thermal switch to turn fan off when LRUs are cooler. Operators wear ear protectors. Actual cockpit noise levels are not expected to be high enough to injure hearing.					
13.	Flight.	Aircraft flying different NAV solution than navigator assumes from his ICDU display.	Any solution selected on the individual ICDU mode control page will be used to generate the data shown on the other pages of that ICDU but will not identify it. Aircraft will be flown manually or coupled according to the selected position on pilot's FDC selector switch (some aircraft can be coupled to CP FDC also).	III	B	Make all solutions displayed on ICDUs match that used by the aircraft when coupled. If manually flown by pilot or CP using their individually selected solution, then pilot's or CP's ICDU should reflect their FDC selector choice. Navigator's ICDU would be free to display only solution selected by him.					

CLASS: I CATASTROPHIC
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PROBABILITY: A - FREQUENT
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END

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